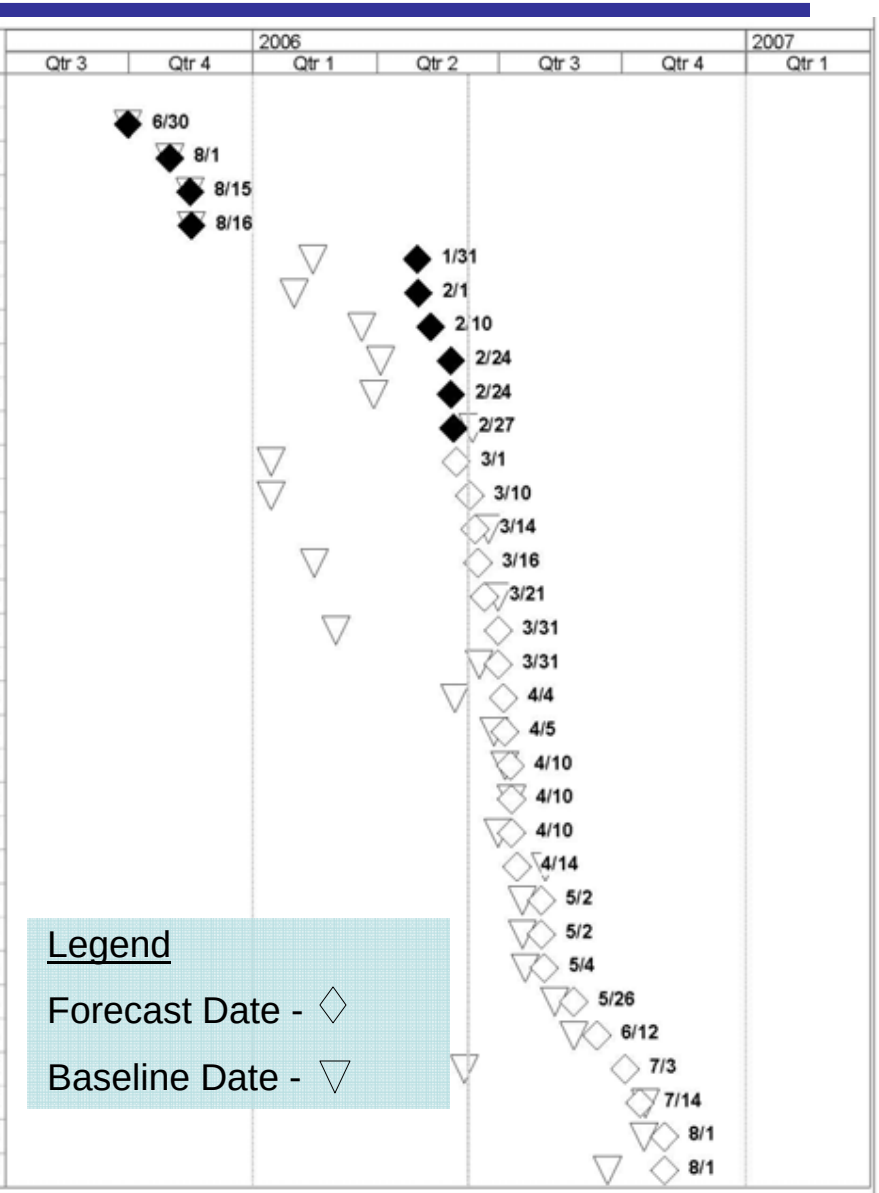
# Proton Plan

# Cost and Schedule Report

Jeff Sims

# Milestones to End of FY06

| WBS | Name | MS Class | Date | Float |
|---|---|---|---|---|
| 1.1.1.1.2 | Linac Task Force Phase 1 Report Issued | C | 2/14/05 | 0 d |
| 1.1.1.1.4 | Linac Task Force Phase 2 Report Issued | C | 6/30/05 | 0 d |
| 1.1.2.1.6 | Linac Quad PS Project Decision | C | 8/1/05 | 0 d |
| 1.3.1.1.3 | WQB Design Complete | C | 8/15/05 | 0 d |
| 1.3.4.1.1.3 | MI RF Cavity Prototype Decision | C | 8/16/05 | 0 d |
| 1.2.2.1.2.6 | OrBump Magnets Ready for Install on Girder | B | 1/31/06 | 0 d |
| 1.5.3 | Submit Final Proton Study Group Report | C | 2/1/06 | 0 d |
| 1.3.1.1.7.4 | WQB Ready for Installation | B | 2/10/06 | 0 d |
| 1.2.4.1.3 | 30 Hz Harmonic Project Decision | C | 2/24/06 | 0 d |
| 1.2.5.1.2 | Gamma-t Studies Complete | C | 2/24/06 | 0 d |
| 1.4.4 | Start 2006 Shutdown | C | 2/27/06 | 0 d |
| 1.3.1.3.4 | WQB P.S. Ready for Installation | B | 3/1/06 | 48 d |
| 1.2.2.1.3.4 | OrBump Stripline Assy Complete | B | 3/10/06 | 27 d |
| 1.3.3.1.4.1.4 | Barrier Bucket Cavity Installation Complete | A | 3/14/06 | 53 d |
| 1.2.2.2.12 | OrBump Power Supply Ready for Installation | B | 3/16/06 | 44 d |
| 1.3.1.3.6 | WQB P.S. Installation Complete | B | 3/21/06 | 48 d |
| 1.2.2.1.4.5 | OrBump Girder Assy Complete | B | 3/31/06 | 16 d |
| 1.2.7.1.3 | Flex Tube Installation Complete | A | 3/31/06 | 20 d |
| 1.2.13.1.10 | Booster RF AC Pulsed Power Improvements Installa | B | 4/4/06 | 38 d |
| 1.2.11.4.23 | Booster Dump Relocation Installation Complete | A | 4/5/06 | 37 d |
| 1.3.3.2.2.3 | Injection Kicker Mod Ready for Installation | C | 4/10/06 | 35 d |
| 1.2.1.1.6 | Booster RF Report Issued | C | 4/10/06 | 714 d |
| 1.3.2.2.5 | MI-8 Collimators Installation Complete | A | 4/10/06 | 34 d |
| 1.3.3.2.3.5 | Injection Kicker Mods Complete | B | 4/14/06 | 30 d |
| 1.3.1.2.6 | WQB Align/Install Complete | B | 5/2/06 | 18 d |
| 1.3.1.3.7 | WQBs System Installed | A | 5/2/06 | 18 d |
| 1.2.2.3.1.6 | OrBump System Installation Complete | A | 5/4/06 | 16 d |
| 1.4.5 | Finish 2006 Shutdown | C | 5/26/06 | 0 d |
| 1.2.2.5 | OrBump System Commissioned | A | 6/12/06 | 670 d |
| 1.3.4.2.2 | MI RF Scope Decision | C | 7/3/06 | -23 d |
| 1.2.3.13.3 | Corrector AIPs Approved | C | 7/14/06 | 31 d |
| 1.2.3.1.6 | Corrector Prototype Magnet Complete | C | 8/1/06 | 55 d |
| 1.2.3.1.7 | Corr Prototype Design Complete | C | 8/1/06 | 19 d |



# Near Future Project Reviews

| WBS | Name | St | Fin | % Complete |
|---|---|---|---|---|
| 1.3.2.1.2.2 | Review Concept for MI-8 Collimation System | Tue 6/7/05 | Tue 6/7/05 | 100% |
| 1.2.2.2.4 | OrBump P.S. Design Review | Wed 6/15/05 | Wed 6/15/05 | 100% |
| 1.2.11.2 | Review Booster Dump Relocation Design | Tue 7/5/05 | Tue 7/5/05 | 100% |
| 1.1.2.1.3 | Linac Quad PS Conceptual Review Prototype | Tue 8/2/05 | Tue 8/2/05 | 100% |
| 1.2.11.4.4 | Booster Dump Relocation Review Monorail Design | Mon 10/10/05 | Fri 10/28/05 | 100% |
| 1.2.4.1.2 | Review 30 Hz Harmonic Concept | Fri 2/24/06 | Fri 2/24/06 | 100% |
| 1.2.5.1.3 | Gamma-t Review/Project Decision | Fri 2/24/06 | Fri 2/24/06 | 100% |
| 1.3.2.1.3.2 | Review Concept for MI Collimation System Being Moved to May | Wed 3/29/06 | Wed 3/29/06 | 0% |
| 1.1.2.2.2 | Linac Quad PS Card Replacement Design Review | Thu 6/22/06 | Thu 6/22/06 | 0% |
| 1.2.3.13.2 | Corrector System Technical Review | Fri 7/7/06 | Fri 7/7/06 | 0% |
| 1.2.12.2.1 | Review Booster Chopper | Fri 7/28/06 | Fri 7/28/06 | 0% |
| 1.1.4.1.3 | 200 Mhz LLRF Design Review | Thu 9/14/06 | Thu 9/14/06 | 0% |

# Critical Path Analysis to mid 2006

| WBS | Name | St | Fin | Float |
|---|---|---|---|---|
| 1.3.1.2.1 | WQB Misc Fabrication | 11/18/05 | 3/9/06 | 6 d |
| 1.3.1.2.2 | WQB Align/Install (5 units) - AD | 3/15/06 | 5/2/06 | 3 d |
| 1.3.1.2.3 | WQB Align/Install (5 units) - PPD | 3/15/06 | 5/2/06 | 3 d |
| 1.3.1.2.4 | WQB Align/Install (Remaining 2 units) - AD | 5/3/06 | 5/23/06 | 3 d |
| 1.3.1.2.5 | WQB Align/Install (Remaining 2 units) - PPD | 5/3/06 | 5/23/06 | 3 d |

Note: Recent delays in the delivery of the Orbump girder have moved it closer to the critical path.

<10 days on installation related tasks
<30 days on fabrication related tasks

PROTON PLAN

# Earned Value

| | | % Complete | | Labor, k | | | | | M&S, k | | | | | Total, k | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Estimate | | IDT | Cost | Schedule | Estimate | | IDT | Cost | Schedule | Cost | Schedule |
| | | Planned | Actual | BCWS | BCWP | ACWP | Variance | Variance | BCWS | BCWP | ACWP | Variance | Variance | Variance | Variance |
| **1** | **Proton Plan** | 31.4% | 29.4% | **3,109** | **2,666** | **2,625** | **41** | **-443** | **2,827** | **2,802** | **2,726** | **76** | **-25** | **117** | **-468** |
| **1.1** | **Linac Upgrades** | 34.1% | 27.7% | **327** | **152** | **162** | **-10** | **-175** | **1,230** | **1,179** | **1,152** | **27** | **-51** | **17** | **-226** |
| 1.1.1 | Linac PA Vulnerability | 35.7% | 32.4% | 30 | 31 | 23 | 8 | 1 | 1,220 | 1,177 | 1,147 | 30 | -43 | **38** | **-42** |
| 1.1.2 | Linac Quad Power Supply | 27.6% | 23.5% | 101 | 87 | 97 | -10 | -14 | 10 | 2 | 2 | 0 | -8 | **-10** | **-22** |
| 1.1.4 | LLRF | 29.2% | 5.0% | 196 | 34 | 42 | -8 | -162 | 0 | 0 | 3 | -3 | 0 | **-11** | **-162** |
| **1.2** | **Booster Upgrades** | 15.8% | 17.1% | **887** | **763** | **814** | **-51** | **-124** | **700** | **797** | **760** | **37** | **97** | **-14** | **-27** |
| 1.2.1 | Determine Rep Rate Limit | 89.0% | 41.6% | 31 | 14 | 7 | 7 | -17 | 1 | 1 | 0 | 1 | 0 | **8** | **-17** |
| 1.2.2 | Orbump System | 82.4% | 81.7% | 210 | 201 | 227 | -26 | -9 | 130 | 129 | 136 | -7 | -1 | **-33** | **-10** |
| 1.2.3 | Corrector System | 7.1% | 6.0% | 280 | 235 | 353 | -118 | -45 | 73 | 59 | 79 | -20 | -14 | **-138** | **-59** |
| 1.2.4 | 30 Hz Harmonic | 10.0% | 10.6% | 116 | 122 | 69 | 53 | 6 | 47 | 51 | 25 | 26 | 4 | **79** | **10** |
| 1.2.5 | Gamma T System | 21.4% | 10.6% | 102 | 51 | 24 | 27 | -51 | 0 | 0 | 0 | 0 | 0 | **27** | **-51** |
| 1.2.7 | Drift Tube Cooling | 63.6% | 18.7% | 4 | 2 | 0 | 2 | -2 | 0 | 0 | 0 | 0 | 0 | **2** | **-2** |
| 1.2.9 | Booster SS RF Upgrade | 20.5% | 17.0% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0** |
| 1.2.11 | Booster Dump Relocation | 40.3% | 49.6% | 113 | 109 | 108 | 1 | -4 | 78 | 179 | 143 | 36 | 101 | **37** | **97** |
| 1.2.12 | Booster Chopper | 0.0% | 0.0% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0** |
| 1.2.13 | Booster RF Modifications | 35.6% | 68.2% | 31 | 29 | 26 | 3 | -2 | 371 | 378 | 377 | 1 | 7 | **4** | **5** |
| **1.3** | **Main Injector Upgrades** | 67.3% | 61.9% | **1,343** | **1,199** | **1,254** | **-55** | **-144** | **893** | **822** | **810** | **12** | **-71** | **-43** | **-215** |
| 1.3.1 | Large Aperature Quads | 86.9% | 85.7% | 901 | 887 | 975 | -88 | -14 | 424 | 419 | 405 | 14 | -5 | **-74** | **-19** |
| 1.3.2 | MI Collimation System | 40.8% | 36.2% | 153 | 124 | 161 | -37 | -29 | 211 | 210 | 227 | -17 | -1 | **-54** | **-30** |
| 1.3.3 | NuMI Multibatch Operation | 59.0% | 46.6% | 268 | 182 | 81 | 101 | -86 | 251 | 190 | 176 | 14 | -61 | **115** | **-147** |
| 1.3.4 | MI RF Upgrade | 97.4% | 30.0% | 21 | 6 | 37 | -31 | -15 | 7 | 3 | 2 | 1 | -4 | **-30** | **-19** |
| **1.4** | **Management** | 36.3% | 36.2% | **542** | **542** | **395** | **147** | **0** | **4** | **4** | **5** | **-1** | **0** | **146** | **0** |
| **1.5** | **Proton Study Group** | 91.5% | 92.0% | **10** | **10** | **0** | **10** | **0** | **0** | **0** | **0** | **0** | **0** | **10** | **0** |

# EV Analysis

- M&S Cost and Schedule Variance. – No issues
- Labor Cost and Schedule Variance.
  - 1.1.4 – LLRF
    - $162k SV –CR # 7 will revise the RLS to match the current approach of modeling now and engineering in Summer of 2006.
  - 1.2.3 - Correctors Prototype
    - Not a linear effort.
  - 1.3.2 - MI Collimation.
    - Delays in simulation and radiation measurements.
  - 1.3.3 – NuMI Multibatch
    - Combination of over estimation of labor and under reporting of effort are resulting in a $101k CV. We will correct this with an upcoming CR.

PROTON PLAN

# M&S Obligation

| M&S Spending by Obligation in $k | | Planned Estimate | | | Prior Years | This FY to date | | ITD | % M&S Used | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Equation* | *(A)* | *(B)* | *(C)* | *(D)* | *(E)* | *(F)* | *(D+F)* | *(D+F)/(A)* | *(D+F)/(B)* | *(D+F)/(C)* |
| | | Through this month | Through FY06 | Total | Obl. | Obl. | Obl+RIP | | ITD/ this month Est | ITD/FY05+ FY06 Est | ITD/Total Est |
| **1** | **Proton Plan** | **3,279.8** | **6,875.3** | **10,055.1** | **2,339.4** | **1,042.9** | **1,054.5** | **3,393.9** | **103%** | **49%** | **34%** |
| **1.1** | **Linac Upgrades** | **1,477.6** | **1,590.5** | **3,299.4** | **1,465.2** | **2.0** | **2.0** | **1,467.2** | **99%** | **92%** | **44%** |
| 1.1.1 | Linac PA Vulnerability | 1,475.6 | 1,475.6 | 3,053.1 | 1,463.6 | -1.2 | -1.2 | 1,462.4 | 99% | 99% | 48% |
| 1.1.2 | Linac Quad Power Supply | 2.0 | 114.9 | 114.9 | 1.6 | 0.3 | 0.3 | 1.9 | 93% | 2% | 2% |
| 1.1.4 | LLRF | 0.0 | 0.0 | 131.5 | 0.0 | 2.9 | 2.9 | 2.9 | 0% | 0% | 2% |
| **1.2** | **Booster Upgrades** | **947.2** | **3,793.8** | **5,254.2** | **247.0** | **789.4** | **789.4** | **1,036.3** | **109%** | **27%** | **20%** |
| 1.2.1 | Determine Rep Rate Limit | 0.8 | 0.8 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0% | 0% | 0% |
| 1.2.2 | Orbump System | 130.0 | 138.6 | 138.6 | 124.5 | 11.2 | 11.2 | 135.7 | 104% | 98% | 98% |
| 1.2.3 | Corrector System | 70.7 | 2,444.9 | 2,779.0 | 20.7 | 142.1 | 142.1 | 162.9 | 230% | 7% | 6% |
| 1.2.4 | 30 Hz Harmonic | 50.0 | 50.0 | 1,108.0 | 24.9 | 0.0 | 0.0 | 24.9 | 50% | 50% | 2% |
| 1.2.5 | Gamma T System | 0.0 | 205.2 | 205.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0% | 0% | 0% |
| 1.2.7 | Drift Tube Cooling | 0.0 | 3.1 | 3.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0% | 0% | 0% |
| 1.2.9 | Booster SS RF Upgrade | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0% | 0% | 0% |
| 1.2.11 | Booster Dump Relocation | 252.7 | 287.6 | 287.6 | 76.8 | 308.3 | 308.3 | 385.1 | 152% | 134% | 134% |
| 1.2.12 | Booster Chopper | 0.0 | 102.6 | 171.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0% | 0% | 0% |
| 1.2.13 | Booster RF Modifications | 442.9 | 561.0 | 561.0 | 0.0 | 327.7 | 327.7 | 327.7 | 74% | 58% | 58% |
| **1.3** | **Main Injector Upgrades** | **839.9** | **1,476.0** | **1,486.6** | **622.8** | **250.9** | **262.5** | **885.3** | **105%** | **60%** | **60%** |
| 1.3.1 | Large Aperature Quads | 422.7 | 489.4 | 489.4 | 362.2 | 71.1 | 71.1 | 433.2 | 102% | 89% | 89% |
| 1.3.2 | MI Collimation System | 208.8 | 621.8 | 632.3 | 175.6 | 59.8 | 64.1 | 239.7 | 115% | 39% | 38% |
| 1.3.3 | NuMI Multibatch Operation | 201.4 | 357.9 | 357.9 | 83.4 | 120.1 | 127.4 | 210.8 | 105% | 59% | 59% |
| 1.3.4 | MI RF Upgrade | 7.0 | 7.0 | 7.0 | 1.7 | 0.0 | 0.0 | 1.7 | 24% | 24% | 24% |
| **1.4** | **Management** | **15.0** | **15.0** | **15.0** | **4.4** | **0.7** | **0.7** | **5.1** | **34%** | **34%** | **34%** |
| **1.5** | **Proton Study Group** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0%** | **0%** | **0%** |

# Effort for February '06

| WBS | WBS Name | Actual FTE | Plan FTE* | |
|---|---|---|---|---|
| **1** | **Proton Plan** | **34.3** | **25.6** | |
| 1.1 | Linac Upgrades | 3.6 | 5.3 | 1 |
| 1.2 | Booster Upgrades | 16.5 | 8.6 | 2 |
| 1.3 | Main Injector Upgrades | 11.6 | 8.2 | 3 |
| 1.4 | Project Management | 2.6 | 3.4 | |
| 1.5 | Proton Study Group | 0.0 | 0.1 | |

*Based on February 2006 Status Update

Variance Notes:

1. 1.1.4 - LLRF – Pushed out Design Effort to Spring 2006. CR #7 will correct this.
2. Orbump required extra efforts due to stripline and magnet measurement issues.
3. WQB and Injection Kicker mods had increased effort in February to prepare for the shutdown.

# Past Changes

- CR-1: Labor Estimate Revisions (Complete)
  - Scope: This change incorporates AD MSD's latest estimate of labor required. This change also addresses Directorate Review comments on Corrector installation labor. It also includes a reduction of effort on 30Hz Harmonic.
    - SWF Increase = $224k
    - M& S Increase = $58k
    - Schedule Impact = No Class A Milestones impacted.
- CR-2: WQB Magnet Fabrication (Complete)
  - Scope: Redesign required for the crossover bus and Utilizing Subcontract Labor to supplement workforce (M&S)
    - SWF Increase = $77k
    - M& S Increase = $54k
    - Schedule Impact = No Class A Milestones Impacted.
- CR-3: Cobra Escalation Correction (Complete)
  - Scope: Document Deltas caused by the difference in esc from MSP to COBRA
    - SWF Increase = $-7k
    - M& S Increase = $48k
    - Schedule Impact = NA
- CR-4: Booster RF Air Switch Replacement (Complete)
  - Scope: Add two new 7 bay air switches for E and W Booster HV supply (+$171k M&S) and Descope 1.2.13.2 "Booster RF Equip Upgrades to Improve Reliability" (- 105k M&S) since no Improvements were identified by 1.2.1
    - SWF Increase = $7k
    - M& S Increase = $66k (net)
    - Schedule Impact = No Class A Milestones Impacted.

# Upcoming Changes

- CR-5: Booster Correctors Estimate Revisions (Ongoing)
  - Scope: Add M&S for Prototyping Efforts and Revise Corrector Fabrication Estimates
    - SWF Increase = To Be Determined
    - M& S Increase = To Be Determined
    - Schedule Impact = To Be Determined
- CR-6: LQPS Card Replacement Estimate Revisions (Complete)
  - Scope: Revised Estimates based on latest knowledge and reduce contingency %
    - SWF Increase = $38k
    - M& S Decrease = $75k
    - Schedule Impact = Moved the class B milestone for completion of LQPS Card Upgrade from 2/19/08 to 7/27/07.
- CR-7: LLRF Estimate Revisions (Ongoing)
  - Scope: Revised Modeling duration and Labor Estimates.
    - SWF Increase = $4
    - M& S Increase = $23k (modeling software)
    - Schedule Impact = No Class A MS impacted
- CR-8: Injection Kicker Mods Revised Estimates (Ongoing)
  - Scope: Revised Estimates based on latest knowledge
    - SWF Increase = To Be Determined
    - M& S Increase = To Be Determined
    - Schedule Impact = To Be Determined